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Redistribution Policy in a Model with Heterogeneous Time Preference *

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Résumé:
Nous examinons comment les politiques redistributrices influencent la distribution du revenu lorsque l'accumulation de capital humain est endogène et que la source fondamentale de l'hétérogénéité dans l'économie provient des différents degrés de préférence pour le présent dans la population. En comparant les états stationnaires d'un modèle d'équilibre général dynamique étalonné pour le Canada, nous trouvons que des programmes de transferts de revenu plus généreux (financés par une imposition uniforme des revenus) ne mènent qu'à de faibles baisses de l'inégalité des revenus, mais augmentent significativement l'inégalité des salaires et mènet à de grandes pertes au niveau du capital par tête. À l'exception du quintile le plus faible, les individus ont une forte prédilection pour la situation de long terme associée à une absence de politique de redistribution. Malgré tout, une majorité vote pour une politique redistributrice en tenant compte des dynamiques de transition. La distribution de la préférence pour le présent joue un rôle crucial pour obtenir ces derniers résultats.

Abstract:
We examine how redistribution policy affects the distribution of income when human capital accumulation is endogenous and the fundamental source of heterogeneity in the economy stems from varying degrees of time preference across members of the population. In comparing the steady states of a dynamic general equilibrium model calibrated to the Canadian economy, we find that progressively more generous income transfer programs (financed with a flat income tax) lead to only modest decreases in income inequality, but significant increases in earnings inequality and large losses in per capita output. With the exception of the bottom income quintile, individuals display a strong preference for the long-run situation associated with the absence of government redistribution policy. Nevertheless, taking into account transition dynamics, a majority of individuals would vote for implementation of redistribution policy. The distribution of time-preference plays a critical role in generating this last result.

Keywords:
Heterogeneous time preference, redistribution, dynamic general equilibrium

JEL classification: D31, D91, E21

Let us have wine and women, mirth and laughter,

Sermons and soda-water the day after.

—Lord Byron in Don Juan

1 Introduction

The purpose of this paper is to explore some of the economic and political aspects of redistribution policy within the context of a particular theory of income distribution. Our analysis is motivated by the desire to provide a theoretical perspective by which to interpret recent trends in labour earnings inequality (e.g., Levy and Murnane, 1992, and Burbidge, Magee and Robb, 1996) and to assess the relative merits of policy debates concerning the role of redistribution policy in either alleviating or exacerbating these trends (e.g., Moffitt, 1990 versus Murray, 1984).

Our theory of income distribution is based on the hypothesis that the fundamental source of heterogeneity across individuals is in their pure rate of time preference, an idea first proposed by the Scottish-Canadian eccentric John Rae (1834) and refined by Irving Fisher (1907). While individuals may differ along a number of other economic dimensions, these differences are interpreted as being primarily a manifestation of heterogeneous time preference. According to Rae, the 'effective desire of accumulation' is a trait that individuals develop early on in life, primarily as a habit that is formed from the example set forth by other members in their society.[1] A number of psychological studies lend support to the idea that time preference or 'the willingness to defer gratification' appears to vary across members of any given population and that furthermore, this trait appears to be firmly established by the time a child reaches adolescence; see, for example, Maital and Maital (1977) and the references cited therein.[2]

[1] At a deeper level, Rae believed that three circumstances were responsible for determining the strength of the accumulative principle among the members of a society: (1) the scope and degree of intra- and intergenerational altruism; (2) the intellectual capacity of society members; and (3) the stability of the legal and political environment (page 124).

[2] Evidently, 'willingness to delay gratification' is a notion that is rooted in Freud's (1911) concept of the pleasure/reality principle.

If individuals do indeed differ in their rate of time preference, as the evidence seems to suggest, then the theoretical implications for income distribution follow more or less immediately: individuals, families and societies that are relatively more patient will over time accumulate relatively more capital from which to draw income. While income inequality does not necessarily imply inequality in wages or labour earnings, if one defines capital broadly to include human capital (the embodiment of accumulated knowledge, skills, technological know-how and health in people), then heterogeneous time preference can manifest itself as differences in individual labour market characteristics as well. In particular, more patient individuals will be more willing to undertake human capital investments like schooling, practicing, training, exercising, and many other costly activities whose payoffs are expected to accrue only in the distant future. Individuals who have accumulated large stocks of human capital tend to be more productive, adaptable, and healthy.[3] Higher productivity naturally leads to higher wages. Increased adaptability provides insurance against adverse economic shocks. Health reduces the risk of disability and illness. Differences such as these manifest themselves as heterogeneous consumptions, employment levels, earned incomes, wealth, and overall well-being.

The forces described above can generally be expected to hold whether or not financial markets exist. The opportunity for intertemporal trade has the effect of mitigating (but not necessarily eliminating) inequality in earnings capabilities but exacerbating inequality in wealth. That is, with complete financial markets, the appropriate discount rate governing human capital investment is given by a (common) market rate of interest; this has an equalizing tendency for the distribution of human capital. On the other hand, because relatively patient individuals are now able to

[3]Rae was well aware of the implications of time preference on health, as the following quote (which is too good to pass up) reveals. After elaborating on the implications of behaviour based on the famous Roman proverb 'When I die, let the world burn,' Rae remarks in a footnote (pg. 159): "A similar proverb *a pres nous le deluge*, is said to have been often in the mouth of Madame Pompadour, one of the purest self-worshippers ever existing. It is perhaps worthy of remark, as showing the propensity of selfishness to grasp the present, that both the Romans and the lady were very prodigals even in what was entirely their own. The former it is well known rapidly exhausted their constitutions by every sort of debauchery and excess, the latter was as little economical of her personal charms. At twenty, her lips are said to have been livid from the too constant application of her teeth to make them pout, at thirty she was haggard."

accumulate claims against the future earnings of the impatient; the latter are gradually reduced to poverty, while the former become correspondingly richer.[4] In reality, individuals are likely constrained in their ability to accumulate a level of debt that would commit themselves to a life of future impoverishment. Such borrowing constraints may to some extent be an endogenous response of the financial market to the fact that some people have very high rates of time preference and that courts would refuse (on moral grounds) to enforce legal contracts which attempt to squeeze blood from a stone.[5] In any case, it seems clear that borrowing constraints are a feature of the economic landscape; in this case, theory predicts a negative relationship between time preference and labour earnings.

The limited amount of economic evidence available is not inconsistent with theory. For example, using the Denver/Seattle Income Maintenance Experiment data, Kurz, Spiegelman, and West (1973) find discount rates ranging between 80 percent per annum for low-income groups and 18 percent for high-income groups. Using household data on the purchase and use of air conditioners, Hausman (1979) estimates that discount rates range between 8.9 and 39 percent per annum and that they vary inversely with income. In both of these studies, the estimated discount rates are marginal rates of substitution, not pure rates of time preference (this distinction is emphasized by Olson and Bailey, 1981). However, Lawrance (1991) uses the Panel Study of Income Dynamics to estimate pure rates of time preference that range from 12 percent for high-income college educated individuals, to 19 percent for low-income individuals without a college education. On the other hand, Ogaki and Atkeson (1997) use a panel of household level data from India to reject the hypothesis of heterogeneous rates of pure time preference in favour of heterogeneous intertemporal elasticities of substitution. A potentially serious drawback to each of these empirical

[4]This conclusion was pointed out by both Rae and Fisher. See also Ramsey (1928) and Stokey and Lucas (1984). Krussel and Smith (1997) demonstrate that even with limited opportunity for intertemporal trade (a rental market for physical capital and borrowing constraints), a very small amount of cross-section variation in time preference rates can generate a quantitatively significant amount of dispersion in income and wealth.

[5]The moral issue seems to based on whether an individual, who at any point in time might be viewed as just one personality in a sequence of time-dated personalities, has the right to excessively discount the well-being of these future personalities.

studies is their reliance on the assumption of perfect capital markets, which has the effect of underestimating the rate of time preference for Lawrance and weakening the case put forth by Ogaki and Atkeson.

If heterogeneous time preference is a primary source of wealth disparity (there are those who argue that the direction of causality may actually run in reverse), then implications for redistribution policy can be important. For example, certain policies that appear to alleviate income inequality may do so primarily in the short run, while actually exacerbating earnings inequality in the long run. Furthermore, such policies may be politically expedient precisely because of the support they might garner from those groups in society that discount the future at relatively high rates. If alleviating earnings inequality is a preferred social outcome, then the theory points to tax instruments that subsidize saving (or even force saving) rather than policies that redistribute incomes via lump-sum transfers. In addition, to the extent that discount rates can be influenced through education (and to the extent that it is deemed desirable to do so), then government resources applied to an appropriate education policy might be a preferred method of alleviating inequality in long run living standards. Many of these interesting issues, especially those that pertain to the endogeneity of time preference (see Becker and Mulligan, 1997) or optimal tax design, will not be explored here. Instead, we will simply view time preference as exogenously determined and proceed to investigate the implications of a redistribution policy that loosely embeds the main incentives arguably found in most modern tax systems.

In a related study, Lawrance (1987) uses a life cycle model with two types of individuals (patient and impatient) in order to quantify the impact of lump-sum intragenerational transfers from rich to poor on aggregate savings, the effects of which were found to be minimal, at least for a model calibrated to the U.S. economy. In contrast, we find that a Canadian style welfare state, which is reasonably approximated by a negative income tax system, can have a significant impact on the level and distribution of economic activity.[6] Our calibrated model illustrates how various

[6]Our set up differs somewhat from Lawrance's. In particular, we allow for distortionary taxation, endogenous labour supply and human capital accumulation in the context of a model with infinitely lived individuals. In addition, the Canadian style welfare state is considerably more generous than

hypothetical changes in government policy might influence the level and distribution of earned income, after-tax income, consumption, labour supply and welfare. In comparing steady states, we find that more generous welfare states generally result in lower average levels for each of these variables; this effect was primarily the consequence of depleted human capital stocks brought about by the disincentives put in place by distortionary income taxes which reduce the return to human capital investment. One exception to this finding was with respect to the welfare level of the bottom quintile, which is shown to increase over a range of 'moderate' redistribution policies. We also find that while redistribution policy reduces inequality in consumption and after-tax income, inequality in earned incomes, labour supply and human capital is increased.

In studying the transition dynamics from laissez-faire toward the steady state associated with some given redistribution policy, we find that the equilibrium trajectories entail a short-run 'utility boom' followed by steadily declining utility levels for all quintiles. For the redistribution policy considered (modelled after Canada), long-run utility levels are lower for everyone with the exception of the bottom quintile. However, the short-run utility boom together with positive discounting implies that the utility payoff associated with implementing the redistribution policy is considerably higher than the utility payoff associated with the steady state of the redistribution policy. Consequently, it may turn out that a majority of individuals would favour implementation of the welfare state, even anticipating that they will in some sense be 'worse off' in the long-run. Thus, not only does the model provide an explanation for the emergence of a welfare state, but it also hints at reasons for why dissatisfaction with the welfare state may grow over time. Indeed, when we consider the steady state associated with a Canadian-style welfare state, we find that a slim majority would actually be in favour of its removal, even taking into account the painful transition dynamics. Consequently, our model may be able to provide the underpinnings of a political model that features alternating episodes of 'liberal' and 'conservative' governments.

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its U.S. counterpart.

The analysis proceeds as follows. Section 2 develops the theoretical setup. In Section 3, the model is parameterized and calibrated using measurements on the distribution of after-tax income across quintiles for the 1994 Canadian economy. Section 4 examines the steady state properties of the model for a number of redistribution policies that differ in their level of generosity. Section 5 briefly considers the transition dynamics for an individual experiencing a taste change. Economy-wide transition dynamics are examined in Sections 6 and 7, following the implementation and removal of a Canadian style welfare state, respectively. Section 8 concludes.

2 The Model

We include only those elements that are necessary to generate an endogenous (nondegenerate) distribution of long-run earnings capabilities and employment levels from an assumed distribution of time preference parameters. To this end, we include human capital and a labour/leisure choice, but abstract from physical capital and uncertainty. The redistribution policies we consider are negative income tax schemes; i.e., universal lump-sum transfers financed by a flat income tax. For simplicity, we abstract from financial market transactions, which implies period-by-period government budget balance and self-financed human capital investment for individuals.

2.1 Individuals

The model considers a fixed population (with unit mass) of infinitely-lived individuals. Time is discrete and denoted by $t = 0, 1, ..., \infty$. There is no uncertainty. Individuals have preferences defined over sequences of consumption and leisure (c_t, l_t) that are represented by the function:

$$\sum_{t=0}^{\infty} \beta^t U(c_t, l_t),$$

where U is strictly increasing and concave, and β represents a time-preference parameter (discount factor). Our analysis allows for the possibility that the discount factor varies across members of the population. Assume that β lies in a discrete set B contained in the open unit interval, and let $\mu(\beta)$ represent the measure of individ-

uals with discount factor β. The model reduces to a standard representative-agent economy when $\mu(\beta) = 1$ for some β in B.

Production of the composite commodity y_t takes place with a technology that is linear in efficiency-units of labour E_t; i.e.,

$$y_t = \omega E_t,$$

where $\omega > 0$ is exogenous and common across individuals. Assume, without loss, that individuals own and operate the production technology. Alternatively, we could assume that the technology is owned by firms and that efficiency-units of labour are traded in a competitive market, in which case ω would represent the equilibrium price of E measured in units of y.

At any point in time, individuals differ in terms of their education and training, or the degree to which their current skills are matched with current wants or technology in the economy; such factors together determine the value of an individual's human capital, $h_t > 0$. Individuals can combine their human capital together with time n_t in order to produce efficiency-units of labour according to:

$$E_t = E(h_t, n_t),$$

where E is strictly increasing, concave, and linearly homogeneous in its arguments. Time not spent working can be applied toward leisure $l_t = T - n_t$, where T denotes the period time endowment.

In reality, a number of economic forces subject individuals to some amount of uncertainty regarding the value of their human capital. For example, the arrival of a new technology or a change in the pattern of tastes for different products may render current skills or accumulated knowledge less valuable if they are not well-matched to the new structure of technology/tastes. Ideally, such an event might be modelled as a stochastic depreciation in the value of human capital, but as we wish to abstract from uncertainty, we shall instead assume that everyone's human capital is subject to a deterministic geometric rate of depreciation $0 \leq \delta \leq 1$.

Human capital can be augmented by diverting goods and services toward general learning activities. For simplicity, assume that new human capital is produced with

exactly the same technology that is used to produce the composite commodity, so that x_t units of output devoted to skill acquisition augments human capital according to the accumulation equation:

$$h_{t+1} = (1 - \delta)h_t + x_t,$$

where $h_0 > 0$ is given. We assume that there are no financial markets, so that individuals must self-finance their learning activities.[7] Finally, human capital is distributed across the population according to probability density function $\lambda_t(h)$; where $\lambda_0(h)$ is given.

2.2 Government

The government of this economy exists to redistribute output. For simplicity, assume that the government supplies a lump-sum universal transfer payment S that is financed by a distortionary income-tax τ (the absence of financial markets precludes the use of bond finance). It is perhaps easiest to think of S as transfer income like subsidies, welfare, unemployment insurance and so on. However, under some mild assumptions concerning the substitutability of government-provided output and private output, one could also interpret S as consisting of government purchases that are supplied to citizens free of charge (more on this below).

Government policy is implemented as follows. At date $t = 0$ the government announces a time-invariant lump-sum subsidy level S and a corresponding income-tax policy $\overline{\tau} \equiv \{\tau_t \mid t \geq 0\}$. Individuals are assumed not to expect any future changes in this government policy.

[7] In the context of the current set-up, the absence of financial markets also guarantees a non-degenerate long-run distribution of wealth.

2.3 Equilibrium

The decision problem for each individual can be stated as follows. Given (h_0, β) and $(\overline{\tau}, S)$, choose $\{c_t, n_t, l_t, h_{t+1}, x_t \mid t \geq 0\}$ in order to solve:

$$\max \sum_{t=0}^{\infty} \beta^t U(c_t, l_t)$$

subject to:

$$\begin{aligned}
(1-\tau_t)\omega E(h_t, n_t) + S - x_t - c_t &\geq 0; \\
h_{t+1} - (1-\delta)h_t - x_t &\geq 0; \\
T - n_t - l_t &\geq 0; \\
c_t, n_t, l_t, h_{t+1}, x_t &\geq 0.
\end{aligned}$$

We will restrict our attention to interior solutions.[8] Hence, an optimal program will satisfy the following restrictions:

$$\begin{aligned}
(1-\tau_t)\omega E_n(h_t, n_t)U_c(c_t, T-n_t) - U_l(c_t, T-n_t) &= 0; \\
-U_c(c_t, T-n_t) + \beta[(1-\tau_{t+1})\omega E_h(h_{t+1}, n_{t+1}) + 1 - \delta]U_c(c_{t+1}, T-n_{t+1}) &= 0;
\end{aligned}$$

where $c_t = (1-\tau_t)\omega E(h_t, n_t) + S - x_t$ and $x_t = h_{t+1} - (1-\delta)h_t$.

While the analysis can easily accommodate heterogeneity in human capital across individuals of a given β, no use of such heterogeneity will be made in the quantitative analysis below. Hence, associate with each β a given initial stock of human capital $\widehat{h}(\beta)$. In this way, we need not condition the optimal program directly on the initial human capital stock. The decision-problem essentially boils down to the choice of the two sequences $\{n_t, h_{t+1}\}$; abusing notation somewhat, let $\{n_t(\beta, S, \overline{\tau}), h_{t+1}(\beta, S, \overline{\tau}) \mid t \geq 0\}$ denote the (unique) solution for a type-β individual faced with government policy $(S, \overline{\tau})$.

[8] For individuals with sufficiently low discount factors, corner solutions may be optimal. In particular, for extremely impatient individuals (anticipating that government charity S will always remain in place), it may be optimal to undertake zero investment in human capital and to devote all available time to leisure activities.

Given a transfer amount S, the government must choose a tax policy $\overline{\tau}$ in order to balance its budget at every date; i.e., τ_t must satisfy:

$$\tau_t \omega \sum_{\beta \in B} E(h_t(\beta, S, \overline{\tau}), n_t(\beta, S, \overline{\tau}))\mu(\beta) = S,$$

for all $t \geq 0$ (where $h_0(\beta, S, \overline{\tau}) = \widehat{h}(\beta)$). In equilibrium, the tax-rate that satisfies this budget constraint at each date is required to be consistent with the tax policy hypothesized by individuals when formulating their labour supply and human capital investment decisions. Note that an equilibrium may not exist for a sufficiently generous transfer S.

2.4 Steady-State

Under suitable restrictions (i.e., the parameterizations considered below), the economy converges to a steady-state featuring a constant tax-rate τ, constant labour supply $n(\beta)$ and human capital stock $h(\beta)$ for each β; these steady-state values satisfy (for an interior solution):

$$(1-\tau)\omega E_n(h(\beta), n(\beta))U_c((1-\tau)\omega E(h(\beta), n(\beta)) - \delta h(\beta) + S, T - n(\beta)) - U_l((1-\tau)\omega E(h(\beta), n(\beta)) - \delta h + S, T - n(\beta)) = 0;$$

$$-1 + \beta[(1-\tau)\omega E_h(h(\beta), n(\beta)) - 1 + \delta] = 0;$$

$$\tau\omega \textstyle\sum_{\beta \in B} E(h(\beta), n(\beta))\mu(\beta) = S.$$

These steady-state restrictions will be used to calibrate the model to the data.

3 Calibration

The model is calibrated to fit various measurements on Canadian income distribution for the year 1994; the data source is Statistics Canada (1996).[9] Income is measured

[9] Figure 1 displays some time series evidence.

in 1994 dollars and is reported as a ratio of the adult population.[10]

Table 1					
	Earned	Total	Transfer	After-Tax	Net Tax
Quintile	Income	Income	Income	Income	Paid
I	1 961	5 289	3 328	5 091	(3 130)
II	7 025	11 379	4 354	10 228	(3 203)
III	15 311	18 603	3 292	15 599	(288)
IV	24 911	27 522	2 611	22 063	2 848
V	46 123	48 167	2 044	36 399	9 724
Mean	19 066	22 192	3 126	18 114	1 190
Std Dev	122 %	84 %	29 %	76 %	

One striking feature of the data in Table 1 is that the dispersion in transfer income across quintiles is considerably less than the dispersion in earned income; the average transfer was \$3126, with a high of \$4354 (accruing to the second quintile) and a low of \$2044 (accruing to the fifth quintile). The lowest quintile received a transfer of \$3328, which is only slightly higher than the economy-wide average transfer.[11] Notice that the dispersion in after-tax incomes is about 40% (46 percentage points) smaller than the dispersion in earned income. Finally, the last column reveals that only the top two quintiles pay more in taxes than they receive in transfers.

According to this data, the average income-tax paid per adult (net of transfers) is \$1190. Presumably, this revenue is used to finance government purchases of goods and services (in addition to interest payments on government debt). In a sense, such expenditures represent a transfer payment to Canadians, but in the form of output instead of cash. If we make the assumption that the government utilizes the same production technology as firms in the private sector (or that the government purchases its output from the private sector) and that individuals view government-provided output as a perfect substitute for market-provided output, then we may proceed by including the \$1190 as a part of transfer income without changing any of

[10]Statistics Canada does not report income per individual adult, focussing instead on 'families' and 'unattached individuals' as well as a composite 'unit' composed of family units and unattached individual units. In deriving income per adult, we make the assumption that the average unit contains two adults (individuals aged 15 and over). Average unit size for 1994 was 2.42 individuals.

[11]Hence, our assumption of a uniform lump-sum transfer does not appear terribly inconsistent with the data.

the theoretical analysis.

The model requires functional forms for U, E, and μ. We specify preferences and technology as follows:

$$\begin{aligned} U(c,l) &= \ln(c) + \lambda \ln(l), \quad \lambda > 0; \\ E(h,n) &= h^{\theta} n^{1-\theta}, \quad 0 < \theta < 1. \end{aligned}$$

Our calibration strategy will involve matching the steady-state after-tax income of population quintiles in the model with those in the data. To this end, we specify $B = \{\beta_1, ..., \beta_5\}$ and $\mu(\beta) = 1/5$ for each β. Altogether then, the model has eleven parameters: $\beta_1, ..., \beta_5, \lambda, \theta, \delta, \omega, T$ and S, for which values must be assigned.

The parameter θ governs the relative importance of human capital in the production of efficiency-units of labour services. We can find no direct evidence pertaining to the likely size of this parameter and so we simply assume that human capital and labour effort are equally important in generating labour services; i.e., $\theta = 1/2$.

A model time-period corresponds to one year. We assume that human capital depreciates at an annual rate of 5%; thus $\delta = 0.05$. With positive depreciation, individuals will in general devote some resources to replenishing their human capital even in a steady-state. For our model economy, a five percent rate of depreciation implies that on average, around 20% of output consists of investments devoted to augmenting human capital.

In their survey of time-use studies, Juster and Stafford (1991) found that individuals report around 100 hours of discretionary time per week (i.e., hours not spent on sleep and personal care); this amounts to approximately $T = 5000$ hours per year. The parameter λ governs the relative importance of leisure in the utility function. The same time-use studies reveal that individuals aged between 25–64 devote, on average, around 2000 hours of their time toward work in the market sector.[12] Because younger adults (those aged 15-24) typically work much less than this, we choose λ to generate an equilibrium labour input of around 1500 hours per adult per year (so

[12]This figure is based on U.S. data for 1981. In that year, men worked 47.5 hours per week, while women worked 25.9 hours per week in the market sector (inclusive of commuting time).

that, on average, people allocate about 30% of their discretionary time to the labour market).

The productivity parameter ω was chosen in order to generate a level of per capita income consistent with observation. The five discount parameters were then allowed to vary in a manner that generated steady-state incomes across quintiles that matched the data. Finally, the subsidy level S was chosen to equal the value of per capita transfer payments to individuals in the economy; i.e., $S = \$4316$. The equilibrium tax-rate required to finance this subsidy is 22.7%.

The model was calibrated to the after-tax distribution of income; the following table reports the calibration results and the model's implications for the distribution of earned-income and the fraction of after-tax income accounted for by transfer income for each quintile in both the model and the data.

Table 2
Canada (1994) vs Calibrated Model

	After-Tax Income		Earned-Income		Transfer Ratio	
Quintile	Data	Model	Data	Model	Data	Model
I	6 281	6 295	1 961	2 559	0.53	0.69
II	11 418	11 454	7 025	9 231	0.38	0.38
III	16 789	16 617	15 311	15 908	0.20	0.26
IV	23 253	23 482	24 911	24 787	0.11	0.18
V	37 589	37 316	46 123	42 678	0.06	0.12
Mean	19 066	19 033	19 066	19 033		
Std Dev	68 %	68 %	122 %	107 %		

The dispersion in earned-income is considerably greater than in after-tax income; the calibrated model replicates this feature of the data, although it appears to overestimate earned-income for the lower quintiles and underestimate earned-income for the upper quintiles. The final two columns report the ratio of transfer income to after-tax income for the data and model. Presumably, allowing the subsidy level and tax rate to vary across quintiles could improve the model's fit along these dimensions.

The parameter values used in calibration are given in Table 3. The model attributes significant differences in the rate of time-preference among individuals occupying different income quintiles. The estimated annual discount rates for quintiles one

through five are: 34.6%, 14.9%, 8.7%, 4.9%, and 1.7%, respectively. Note that while these calibrated discount rates are within the range reported in empirical studies, the model does have an unfortunate feature in that particular discount rates are so tightly associated with given income quintiles. Implementing some of the extensions discussed in the concluding section below would contribute to the descriptive realism of the model.

Table 3
Parameter Values

β_1	β_2	β_3	β_4	β_5	δ	θ	ω	λ	T	S
0.743	0.870	0.920	0.953	0.983	0.05	0.50	1.905	0.95	5000	4316

In addition to income distributions, for which relatively good measurements are available, the model also makes predictions concerning labour supplies, wage rates, consumption levels and the value of human capital wealth across income quintiles. This information is presented in Table 4.

Table 4

Quintile	Labour Supply	Wage Rate	Consumption Expenditure	Investment Rate	Human Capital
I	722	3.54	6 170	0.02	2 499
II	1 312	7.04	10 559	0.08	17 896
III	1 553	10.24	14 372	0.13	44 908
IV	1 755	14.13	18 658	0.20	96 490
V	2 047	20.85	25 057	0.33	245 194
Mean	1 478	11.16	14 963	0.15	81 398
Std Dev	40 %	68 %	54 %	12 %	175 %

The model generates a considerable amount of heterogeneity in hours worked, ranging from 722 hours per year (14 hours per week) to 2047 hours per year (40 hours per week). High-income earners generate high levels of income in part because they work relatively long hours. These individuals devote such a high fraction of their time to work activities partly because the return to work is so high: the average hourly wage for upper quintile individuals is \$20.85 compared to just \$3.54 for lower quintile individuals. The return to work for upper quintile individuals is so high because they are so skilled: the value of their human capital is estimated to be $\$245,194$ compared to only $\$2,499$ for the lowest-skilled individuals. Notice that

the disparity in human capital wealth (standard deviation of 175%) is much higher than the disparity in earned income (standard deviation of 107%).[13] Upper quintile groups are more skilled because they devote a higher fraction of their resources toward building and maintaining human capital (this behaviour is a direct manifestation of their lower discount rates). The highest quintile devotes about 33% of their work-time and human capital resources simply toward building new human capital, while the lowest quintile devotes only 2% of their resources for this purpose. Finally, note that the dispersion in material well-being, as measured by consumption levels, is considerably less than the dispersion in even after-tax incomes. In addition, since higher income individuals sacrifice a significantly higher fraction of their leisure time in the form of work, measures of income dispersion to a large extent likely overstate the actual disparity of living standards in the economy.

4 Steady-State Analysis

In this section, we examine how the steady-state of our model economy responds as the government transfer is increased in one-thousand dollar increments:

$$S \in \{0, 1000, 2000, 3000, 4000, 4850\};$$

(Note: \$4850 appears to be the maximum feasible level of per capita government spending for the parameterization considered here). We report results for the following six variables: after-tax income, earned income, consumption, labour supply, human capital, and welfare across income quintiles.

4.1 After-Tax Income

The tables below are constructed as follows. The first column reports the level for the relevant variable (in this case, after-tax income) for each quintile under the 'laissez-

[13] Evidently, most models predict the opposite here; see Jovanovic (1997). In the data, the dispersion in wealth is much greater than the dispersion in income, so our model apparently provides an answer to this puzzle.

faire' regime ($S = 0$). The columns corresponding to positive subsidy levels record the ratio of the variable relative to its laissez-faire level.

Subsidy	0	1000	2000	3000	4000	4850
Quintile						
I	08243	0.969	0.930	0.878	0.800	0.629
II	17091	0.947	0.886	0.813	0.714	0.524
III	25946	0.940	0.873	0.792	0.686	0.490
IV	37720	0.936	0.864	0.780	0.670	0.470
V	61445	0.933	0.857	0.769	0.655	0.453
Average	30089	0.938	0.869	0.787	0.679	0.481
Std Dev	68.6%	0.988	0.974	0.956	0.932	0.885

Annual per capita income for Canada in 1994 was $\$19,033$, which is about 63% the level predicted by our model under a laissez-faire regime ($\$30,089$); our model suggests that the Canadian welfare state has had a huge negative impact on total earnings. On the other hand, increasing the generosity of the welfare state does appear to reduce after-tax income inequality. For example, a subsidy level of $\$4,000$ is predicted to reduce the standard deviation of after-tax income by 6.8%. However, notice that the after-tax income of all quintiles is predicted to fall as generosity is increased; the after-tax income distribution is compressed because the after-tax incomes of the rich fall proportionately more than the poor.

4.2 Earned Income

Subsidy	0	1000	2000	3000	4000	4850
Quintile						
I	08243	0.879	0.744	0.588	0.392	0.061
II	17091	0.921	0.833	0.730	0.596	0.361
III	25946	0.935	0.861	0.775	0.661	0.456
IV	37720	0.943	0.878	0.802	0.734	0.513
V	61445	0.950	0.893	0.825	0.734	0.562
Average	30089	0.938	0.869	0.787	0.679	0.481
Std Dev	68.6%	1.024	1.054	1.095	1.160	1.330

Under laissez-faire, earned income corresponds to after-tax income, which is why the first column of the table above corresponds to the first column of the previous

table. As the generosity of the welfare state is increased, earned incomes for all quintiles is reduced. Notice that earned incomes fall (relative to after-tax incomes) at a greater rate for the poor but at a slower rate for the rich; at the highest subsidy level, earned income for the bottom quintile is 6.1% of what they would be earning under laissez-faire (after-tax income is at 62.9%), while earned income for the top quintile is 56.2% of what they would be earning under laissez-faire (after-tax income is at 45.3%). Consequently, the dispersion in the distribution of earned incomes is predicted to rise along with the generosity of the welfare state.

This last result provides an important caveat for policymakers and analysts who assert that the increased generosity of the welfare state has stabilized after-tax income inequality in the face of an exogenous increase in earned income inequality (e.g., see Little, 1995). Here we have developed a model in which the direction of causality runs in reverse: it is the increased generosity of the welfare state itself that leads to an increase in earned income inequality.

4.3 Consumption

Subsidy	0	1000	2000	3000	4000	4850
Quintile						
I	07723	0.977	0.946	0.902	0.833	0.668
II	14949	0.956	0.903	0.838	0.747	0.564
III	21210	0.949	0.890	0.818	0.721	0.532
IV	28225	0.945	0.882	0.806	0.705	0.513
V	38618	0.942	0.876	0.798	0.694	0.500
Average	22144	0.948	0.889	0.817	0.719	0.530
Std Dev	53.9%	0.984	0.966	0.945	0.917	0.863

Consumption levels across quintiles behave in a manner that is very similar to after-tax income levels as the generosity of the welfare state is increased. Notice that the standard deviation in consumption across quintiles is about fifteen percentage points less than the standard deviation in after-tax income for each subsidy level. Thus, measures of dispersion in after-tax income likely overestimate actual inequality in material well-being (as measured by consumption).

4.4 Labour Supply

Subsidy	0	1000	2000	3000	4000	4850
Quintile						
I	1799	0.911	0.806	0.674	0.487	0.091
II	1878	0.955	0.902	0.836	0.742	0.542
III	1958	0.969	0.933	0.887	0.823	0.686
IV	2065	0.978	0.951	0.918	0.871	0.772
V	2279	0.985	0.967	0.945	0.913	0.845
Average	1996	0.961	0.916	0.859	0.778	0.606
Std Dev	9.3%	1.281	1.660	2.207	3.135	5.958

The labour supply response to increased tax/subsidy levels is not quite as severe as the response observed in earned incomes. Nevertheless, the labour input declines significantly for all quintiles as the generosity of the welfare state is increased, with the lower quintiles being particularly affected. Notice that while a more generous welfare state reduces consumption inequality, it leads to an increase in the inequality of leisure (consumption of home produced goods and services); for the highest subsidy level considered here, the inequality in labour supply increases sixfold.

4.5 Human Capital

Subsidy	0	1000	2000	3000	4000	4850
Quintile						
I	010411	0.848	0.687	0.514	0.315	0.040
II	042851	0.889	0.769	0.637	0.480	0.240
III	094723	0.902	0.795	0.677	0.532	0.303
IV	189897	0.910	0.811	0.700	0.563	0.342
V	456544	0.916	0.825	0.720	0.590	0.374
Average	158885	0.911	0.813	0.703	0.567	0.346
Std Dev	113%	1.009	1.020	1.034	1.057	1.113

The value of individuals' human capital stock affect their earnings capabilities (real wages). Observe that the human capital response to increased tax/subsidy levels is more severe than the response observed in earned incomes. Under the most generous welfare state, the value a person's human capital skills in the lowest quintile is depleted to 4% of the value that would have prevailed under laissez-faire. Under

even more generous welfare provision, the lowest quintile would reach a corner in their labour supply decision and allow their human capital to depreciate fully, at least, to the extent that they expect that the transfer payment will remain available for the indefinite future. Note that in this case, an unexpected removal of the welfare state could leave such individuals in extremely dire straits, as they would have virtually no means by which to generate any decent earnings. Such a scenario appears to be playing out in various regions of Canada today.

4.6 Welfare

Subsidy	0	1000	2000	3000	4000	4850
Quintile						
I	0064.66	1.001	1.003	1.003	1.003	0.999
II	0132.74	0.999	0.997	0.995	0.991	0.980
III	0219.77	0.998	0.996	0.992	0.987	0.974
IV	0379.43	0.998	0.995	0.991	0.985	0.971
V	1063.22	0.997	0.994	0.990	0.983	0.968
Average	371.97	0.998	0.995	0.991	0.985	0.971
Std Dev	109%	0.999	0.999	0.998	0.997	0.995

The level of welfare is measured by the steady-state maximum value function $W_i = (1-\beta_i)^{-1}U(c_i^*, \ell_i^*)$ for each quintile i. In comparing steady-states, quintiles II–V strictly prefer the laissez-faire regime to any welfare state, with economic welfare declining monotonically as generosity increases. The bottom quintile, on the other hand, actually appears to prefer redistribution policy, as long as it is not too generous; for this quintile, steady-state welfare is maximized at a subsidy level of around \$3000.

In evaluating the pattern of economic welfare across quintiles for different redistribution policies, it seems apparent that a clear majority of individuals prefer (and presumably would vote for) the laissez-faire regime. How then is one to rationalize the existence of the welfare state in such an environment? In the sequel, we consider one possible answer to this puzzle, which is based on the way transition dynamics following implementation of a redistribution policy might influence the distribution of welfare benefits accruing to different quintiles in a way that makes implementation politically viable.

5 Individual Transition Dynamics

One question of interest regards the extent to which individuals in this environment are able to move themselves into higher income quintiles, should they decide to undertake the necessary investments. In order to answer this question, we begin the economy in its steady-state, holding government policy fixed $(\tau, S) = (0.227, 4316)$. Now suppose that someone in the lowest quintile desires to move into the second quintile; i.e., suppose that for some exogenous reason, this person switches his discount factor from $\beta_1 = 0.743$ to $\beta_2 = 0.870$. How long does it take for the person to make the transition optimally and what does the transition path look like?

Figure 2 plots the optimal transition path. As the figure makes clear, undertaking the transition to the higher quintile entails a significant cost in short-term living standards (a cost that very impatient individuals are unwilling to bear). In the first year of the transition, the individual must be willing to reduce material living standards by 20% ($1262) while at the same time increasing work effort by 38% (277 hours or 8 additional weeks of full-time work). Consumption spending actually remains below its initial value for a full two years into the transition, but rises gradually to its higher steady-state level ($10,559), completing much of the transition after about 20 years. Work effort appears to approach its higher steady-state level (1312 hours) in about 10 years.

The experiment above describes what would happen if a 'small' number of individuals were somehow compelled to change their time-preference. Should a 'large' number (some positive measure) of individuals undertake a similar change, the assumption of a fixed government policy would no longer be valid and one would have to compute the general equilibrium implications of such a change (i.e., equilibrium tax rates would change along the transition path, inducing further changes in behaviour).

6 Implementation of the Welfare State

Imagine that the economy has over a period of time settled into the laissez-faire steady-state; i.e., individuals have based their economic decisions in the absence of government redistribution policy and under the expectation that zero taxes/transfers would be a part of the economic landscape for the indefinite future. We begin our observation of this economy at some arbitrary time period $t = 1$. Now, assume that at the end of time period $t = 10$, the government suddenly (and unexpectedly) announces that it will be distributing a transfer payment $S = \$4316$ (à la Canada 1994) to each member of the economy for all future time periods $t > 10$. Of course, at the same time the government announces (or, in the absence of an announcement, people can figure out) a corresponding budget-balancing income-tax $\{\tau_t \mid t > 10\}$. We ask two questions: What is the nature of the ensuing transition dynamics toward the new steady state; and what sort of political support might such a policy garner?

The resulting transition dynamics for earned and after-tax incomes are plotted in the top panel of Figure 3. Under the laissez-faire regime, earned and after-tax incomes coincide, while under the welfare state, earned and after-tax incomes diverge, with earned incomes being larger than after-tax incomes for only the top two quintiles. Immediately following the government's announcement, earned incomes fall dramatically for all quintiles. Earned incomes fall proportionately a little more for the lower quintiles, which is why earned income inequality rises moderately on impact (see bottom panel). After-tax incomes drop by even more than earned incomes for the top two quintiles, while for the bottom quintile, after-tax income actually rises on impact, all of which contributes to a reduction in after-tax income inequality. Along the transition path, earned and after-tax incomes converge monotonically to their lower steady state values with the net tax bill for each quintile remaining more or less stable. Observe that after-tax income inequality reaches a minimum in the period of implementation; subsequently, inequality rises but remains below its initial steady state level. On the other hand, inequality in earned incomes continues to rise throughout the transition period.

Figure 4 records the transition dynamics for consumption and labour supply (leisure) across income quintiles. The most striking feature of these transition dynamics is the general 'consumption boom' that immediately follows the implementation of the welfare state; consumption of both market output and leisure (home production) increase significantly, with the lower income quintiles displaying proportionately larger changes. Most of the adjustment in labour supply occurs in the impact period of the policy change, although the labour input of the bottom quintile appears to show some continued adjustment (downward) for close to twenty years. This adjustment in the labour supply accounts for the bulk of the short-run change in earned incomes described above. In contrast, the consumption boom in market-produced output is relatively short-lived, lasting for only a few years (the duration of the boom is longer for lower quintile groups). This consumption boom, together with the behaviour of after-tax incomes, implies that individuals are substituting away from human capital investment; this depletion of the human capital stock erodes productivity and is what causes the gradual decline of earned incomes (following the impact period) toward the new steady state. Notice that earned incomes fall in the short run because of the reduction in employment; however, the bulk of the long-term decline in earned incomes comes about because of reduced long-run productivity. As earning capabilities are gradually eroded, consumption possibilities across all quintiles fall below their initial steady state levels, with the upper quintiles experiencing proportionately greater losses.

What are the economic incentives at work that generate these transition dynamics? A number of different forces are at work. To begin, there is the lump-sum transfer payment. As this income is perceived to be permanent, one would expect it to result in an increase in consumer demand roughly equal to the amount of the transfer. In addition, the same wealth effect would induce an increase in the demand for leisure. On the other hand, individuals are also expecting a sequence of distortionary income taxes, as plotted in Figure 5. In the period of implementation, the government must levy a 16% income tax, which generates an income effect that works in a direction opposite to that of the subsidy. In their net effects, one might expect that these

two income effects roughly cancel each other out; the negative income effect likely dominates in the upper quintiles (as they are net contributors of tax revenue), while the positive income effect likely dominates in the lower quintiles (as they are net recipients of transfer income). The distortionary tax also has the effect of making work less attractive relative to leisure. All of these forces taken together contribute to a decline in work effort across all quintiles, with a larger decline witnessed among the lower quintiles.

Along the transition path, the income tax rate rises monotonically to its new steady state of 22.7%. This gradual tax hike is required to finance the transfer program in the face of a shrinking tax base. The tax base shrinks along the transition path not because of lower employment, but because of lower productivity. Productivity falls because individuals are induced to substitute away from human capital investment (future consumption) and into current consumption. Individuals substitute away from human capital investment because its return (higher future wages) is taxed at a higher rate. As the human capital stock is depleted, reduced wealth levels translate into lower consumption. One might expect these reduced wealth levels to stimulate employment to some extent, but working against this force is the fact that the return to working falls along the transition path, both because income tax rates are rising and because real wages are falling (along with reduced human capital).

It is interesting to examine how different groups in society view the desirability of the welfare state, both from a 'long-run' perspective (i.e., simply comparing steady states), and taking into account the transition dynamics toward the new steady state. Figure 6 records how momentary utility, $u_t = \ln(c_t) + 0.95\ln(\ell_t)$, evolves for each quintile following the implementation of the welfare state. As the figure makes clear, and as is consistent with the steady state analysis explored earlier, the long-run utility levels are higher in the welfare state only for the bottom income quintile.

In order to get a feel for the quantitative magnitude of utility gain or loss, we can construct an 'equivalent variation' measure as follows. Let

$$v_i^{LF}(\zeta) = (1-\beta_i)^{-1}U((1-\zeta)c_i^{LF}, \ell_i^{LF})$$

denote the utility payoff from living in the steady state of the laissez-faire regime for an individual of type i when subject to a 'tax' on consumption equal to rate ζ. Let

$$v_i^{WS} = (1-\beta_i)^{-1} U(c_i^{WS}, \ell_i^{WS})$$

denote the utility payoff from living in the steady state of the welfare state regime for an individual of type i. For each individual, compute the ζ_i that satisfies:

$$v_i^{LF}(\zeta_i) = v_i^{WS}.$$

The value ζ_i has the interpretation of being the maximum rate of consumption that an individual of type i would be willing to sacrifice (in perpetuity) for the opportunity of remaining in the laissez-faire regime rather than being transported instantly to the steady state of the welfare state regime. Thus, ζ_i is a measure of the welfare loss that would be realized in moving to the welfare state. For our parameterization, these welfare losses are given by:

Table 5

	I	II	III	IV	V
$\zeta_i \times 100$	-5.2	17.2	23.7	27.3	29.9

As Table 5 reveals, the welfare cost associated with the welfare state is very large for the upper four income quintiles; these individuals would willingly sacrifice up to 30% of their consumption for the opportunity of remaining in the laissez-faire regime. On the other hand, the bottom quintile would have to have its consumption augmented by 5.2% in order for these people to become indifferent between the steady state of the two regimes.

From Table 5, it is clear that the majority of individuals strongly prefer the laissez-faire regime to the welfare state regime. Is there any way to rationalize the existence of the welfare state in the context of this environment? Surprisingly (to us, at least), the answer is 'yes'. To see this, let us compute the utility payoff of implementing the welfare state, taking into account the transition dynamics toward the new steady state:

$$v_i^{IWS} = \sum_{t=0}^{\infty} \beta_i^t U(c_{it}^{IWS}, \ell_{it}^{IWS}),$$

where c_{it}^{IWS} and ℓ_{it}^{IWS} represent the equilibrium consumption and leisure dynamics following the change in policy. In order to quantify the welfare loss of implementing this policy, compute the ξ_i that satisfies:

$$v_i^{LF}(\xi_i) = v_i^{IWS},$$

for each income quintile i. The value ξ_i represents the maximum rate of consumption that an individual of type i would be willing to sacrifice (in perpetuity) for the opportunity of remaining in the laissez-faire regime rather than having to live through the transition dynamics associated with the implementation of the welfare state. From Figure 6, it is clear that $v_i^{WS} < v_i^{IWS}$ for each i, so that $\zeta_i > \xi_i$. In other words, living through the transition dynamics lowers the welfare cost of implementing the welfare state; the following table quantifies these costs:

Table 6

	I	II	III	IV	V
$\xi_i \times 100$	-46.6	-12.1	-0.3	8.4	21.1

Evidently, the short-run momentary-utility boom results in a significant reduction in the cost of implementing the welfare state, with the lower quintiles experiencing a proportionately greater benefit. This larger benefit accrues for two reasons. First, the short-run increase in momentary utility is proportionately larger for lower quintiles, because of their proportionately larger consumption and employment responses, as described earlier. Second, the lower quintiles attach a relatively greater weight to these short-run benefits as a result of their higher discount rates. As a result, the costs of implementation are now so much reduced that the second and third income quintiles actually prefer its implementation, relative to remaining in the laissez-faire state. Hence, quintiles I–III could presumably use their majority to vote in a government committed to implementing (and maintaining) the welfare state, even though quintiles II and III understand that they will come to 'regret' its implementation. For these two quintiles, the short-lived but proximate periods of 'mirth and laughter' more than make up for the 'sermons and soda-water' that occur only in the distant future. And for the bottom quintile, the mirth evidently never ends.

7 Welfare Reform

This section briefly describes (in the absence of diagrams) the transition dynamics that take place when the welfare state is removed and the economy converges to the steady state associated with the laissez-faire regime. For the most part, the dynamics are the same as described earlier, only in reverse. However, this transition is not a simple mirror image of the earlier one, primarily because the income-tax dynamics now display a simple 'step' pattern (from the initial steady state to the new steady state), with no corresponding adjustment period.

As before, while the transition period appears to vary across quintiles, it appears that the bulk of the transition is completed after about twenty years. With the exception of the top quintile, all other groups in the economy experience an immediate, but temporary, decline in their material well-being as measured by consumption expenditure. The severity of the consumption decline is greater for poorer individuals. For example, the bottom quintile is compelled to reduce consumption spending in the first year by \$3000, which represents almost a 50% decline. It takes these individuals a full six years of hard work and investment before they recover their initial level of material well-being. Beyond the sixth period of adjustment, consumption grows steadily beyond its initial level of \$6170, approaching \$7723 asymptotically. Consumption also declines for the middle quintile, who pay close to zero in net taxes. The consumption decline here largely represents the attempt by these individuals to divert income away from consumption toward human capital investment, which has now suddenly become more attractive.

All groups are encouraged to increase their work effort in response to the tax reform, with lower-income groups doing the bulk of the adjustment (higher income groups are already working many hours). However, the economic forces that motivate this increased work effort differ across quintiles. For poorer individuals, who are initially net recipients of transfer income, the removal of government-provided output/income makes longer hours of work (at still very low wages) necessary in order to maintain material living standards. For richer individuals, who are initially

net contributors of tax revenue, leisure time is now made more feasible, but the removal of the distortionary income-tax increases the attractiveness of work and further investment in human capital.

With the exception of the poorest individuals, after-tax income rises in all periods following the reforms. For the top two quintiles, after-tax incomes rise because they pay less in taxes and also work harder. For the next two quintiles, after-tax incomes rise solely because of increased work effort. For the bottom quintile, the increase in earned income is not initially sufficient to make up for lost transfer income.

Removal of the welfare state is predicted to increase per capita income dramatically on impact; this larger income is the result of greater work effort. Subsequently, work effort declines to its new (and higher) steady-state level, but incomes continue to rise because workers are becoming more productive. Labour productivity rises through the increased investment in human capital stimulated by the tax reform. However, while average income rises sharply on impact, so does the degree of after-tax income inequality. To a large extent, income inequality increases because the rich are gaining proportionately more than other classes, although the lowest quintile does experience an absolute decline in after-tax income. The model predicts that income disparity will be greatest within the first five years of the reform; after this period of time, inequality falls substantially, but remains higher than before (of course, the level of income for all quintiles is at this stage higher than their initial levels).

It is interesting to examine how economic welfare is affected with the removal of the welfare state. Of course, we already know that in comparing steady states, the majority of individuals prefer the laissez-faire regime. However, as the equilibrium transition dynamics to the laissez-faire steady state involve significant short-run costs (reduced consumption and increased work effort), welfare reform may not be attractive to the majority of individuals. Let

$$v_i^{ILF} = \sum_{t=0}^{\infty} \beta_i^t U(c_{it}^{ILF}, \ell_{it}^{ILF}),$$

where c_{it}^{ILF} and ℓ_{it}^{ILF} represent the equilibrium consumption and leisure dynamics following the change in policy. In order to quantify the welfare loss of implementing

this policy, compute the ξ_i that satisfies:

$$v_i^{WS}(\xi_i) = v_i^{ILF},$$

for each income quintile i, where $v_i^{WS}(\xi_i) \equiv (1-\beta_i)^{-1}U((1-\xi_i)c_i^{WS}, \ell_i^{WS})$ is the utility payoff associated with the steady state of the welfare state, when subject to a consumption 'tax' ξ_i. The value ξ_i represents the maximum amount of consumption that an individual of type i would be willing to sacrifice (in perpetuity) for the opportunity of remaining in the welfare state regime rather than having to live through the transition dynamics associated with the implementation of the laissez-faire regime. Thus, ξ_i gives us a quantitative measure of the welfare cost of implementing the removal of the welfare state; for our parameterization, these numbers are:

Table 7

	I	II	III	IV	V
$\xi_i \times 100$	47.5	14.2	-0.3	-11.7	-23.9

From the above table, it appears that while the bottom two quintiles would find the dismantling of the welfare state extremely disagreeable, the majority of the population would actually vote in favour of the reform, with the middle quintile being close to indifferent.

8 Summary and Conclusions

In this paper, we have developed a theory of the distribution of income and applied it to various questions concerning the likely economic consequences of redistribution policy. A parameterized version of the model was calibrated to match key properties of the Canadian data on after-tax income distribution, labour supply, and government policy. The model was found to display a considerable amount of heterogeneity along several economic dimensions, even though individuals differed fundamentally only in their rate of time-preference.

The calibrated model was then used to illustrate how various hypothetical changes in government policy might influence the level and distribution of earned income,

after-tax income, consumption, labour supply and welfare. In comparing steady states, more generous welfare states generally resulted in lower average levels for each of these variables across quintiles; this effect was primarily the consequence of depleted human capital stocks brought about by the disincentives put in place by distortionary income taxes which reduced the return to human capital investment. One exception to this finding was with respect to the welfare level of the bottom quintile, which was shown to increase over a range of 'moderate' redistribution policy. It was also shown that while redistribution policy reduced inequality in consumption and after-tax income, inequality in earned incomes, labour supply and human capital was increased.

In studying the transition dynamics from laissez-faire toward the steady state associated with some given redistribution policy, we found that the equilibrium trajectories entailed a short-run 'utility boom' followed by steadily declining utility levels for all quintiles. For the redistribution policy considered (modelled after Canada), long-run utility levels were lower for everyone with the exception of the bottom quintile. However, the short-run utility boom together with positive discounting implies that the utility payoff associated with implementing the redistribution policy is considerably higher than the utility payoff associated with the steady state of the redistribution policy. Consequently, it may turn out (as it did with our parameterization) that a majority of individuals would favour implementation of the welfare state, even anticipating that they will in some sense be worse off in the long-run. Thus, not only does the model provide an explanation for the emergence of a welfare state, but it also hints at reasons for why dissatisfaction with the welfare state may grow over time. Indeed, when we considered the steady state associated with a Canadian-style welfare state, we found that a slim majority would actually be in favour of its removal. Consequently, our model may be able to provide the underpinnings for a political model that features alternating episodes of 'liberal' and 'conservative' governments.

There are a number of obvious ways in which the model above may be fruitfully modified. While useful as an illustrative device, the model's quantitative implications cannot be taken too seriously. Introducing an alternative tradable asset, like physical

capital, would likely be required in order to arrive at more precise estimates; in another paper, Andolfatto and Redekop (1998) provide a framework allowing for such an extension. Incorporating financial markets would be interesting, although some form of borrowing constraints would likely be necessary in order to guarantee the existence of a nondegenerate steady-state distribution of wealth. One possible twist could be to allow only the government to borrow; doing so would allow one study the optimal timing of taxes in financing any given policy reform.

One shortcoming of our model is that it attributes all heterogeneity in human capital to differences in discount rates. Surely, a good portion of the actual cross-section variation in human capital can be accounted for by simple life-cycle considerations; hence, redeveloping the analytical framework above in a life-cycle model could prove useful. Doing so in conjunction with explicit reference to politico-economic equilibrium concepts may prove especially interesting; see Krussel, Rios-Rull and Smith (1997) and Cooley and Soares (1998). For example, one might ask to what extent welfare reform would be hindered by older generations who vote knowing that they are not likely to live much beyond the difficult transition period.[14] As well, life-cycle considerations would generate some mobility for individuals across income and wealth quintiles, which is a feature of the data; see for example Schiller (1977) and Jianakoplos and Menchik (1997).

A gross abstraction in the analysis above is the absence of idiosyncratic uncertainty. However, the importance of this assumption likely depends on the set of questions to be addressed. We conjecture that incorporating idiosyncratic uncertainty (in say, the productivity of individual human capital stocks) would go a long way in adding to the descriptive realism of the model's predictions, especially in terms of income mobility, but is unlikely to alter any of the main conclusions drawn above. However, one possible exception to this last statement may be in the predicted welfare benefits of redistribution policy, which are likely to increase somewhat, especially if private insurance markets are incomplete; see Andolfatto and Gomme (1996).

[14] In effect, this is a variant of our discounting story, at least, to the extent that people fully discount consumption profiles beyond their life.

FIGURE 1
Income-Taxes and Transfers
as a Ratio of Total Income
Canada

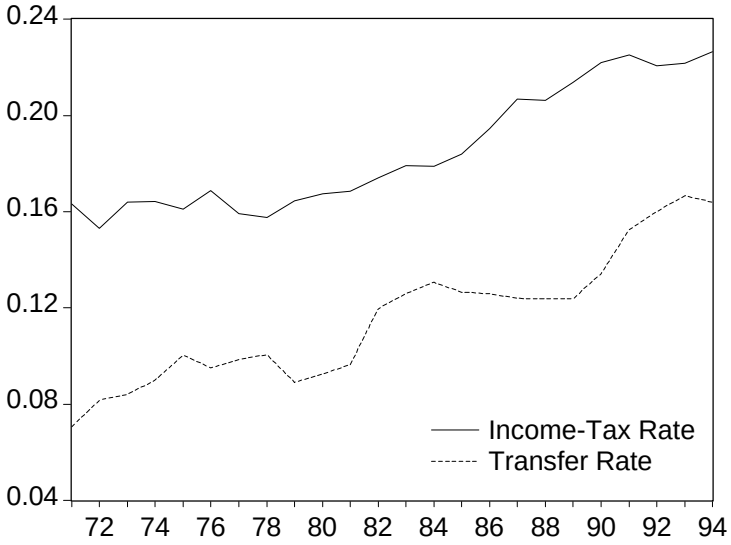


FIGURE 2

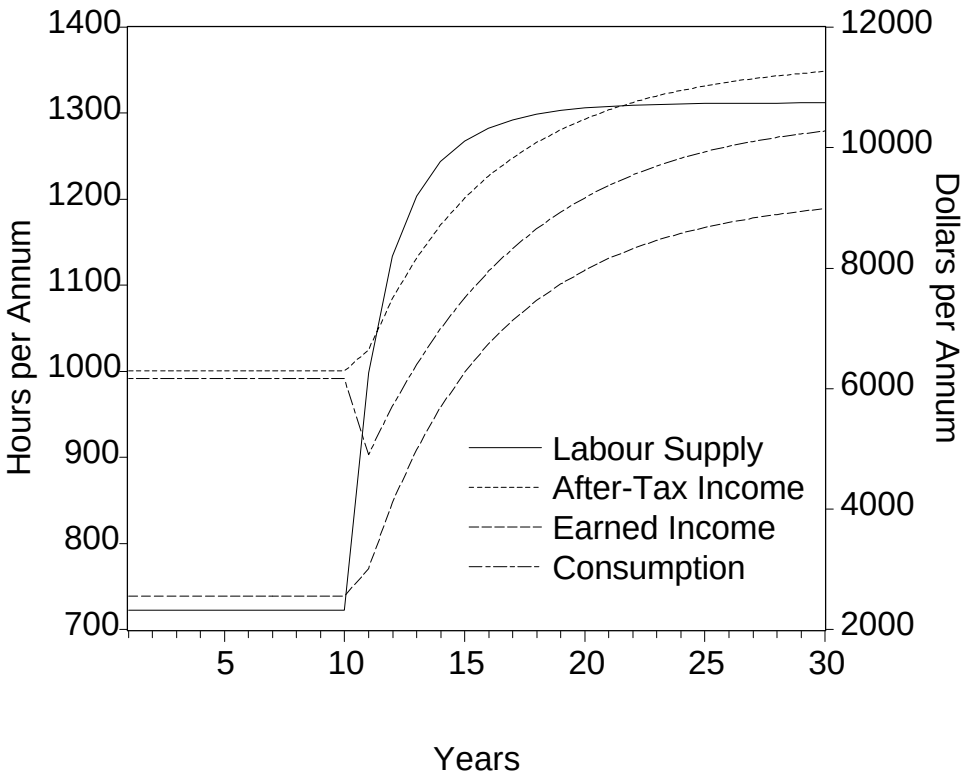
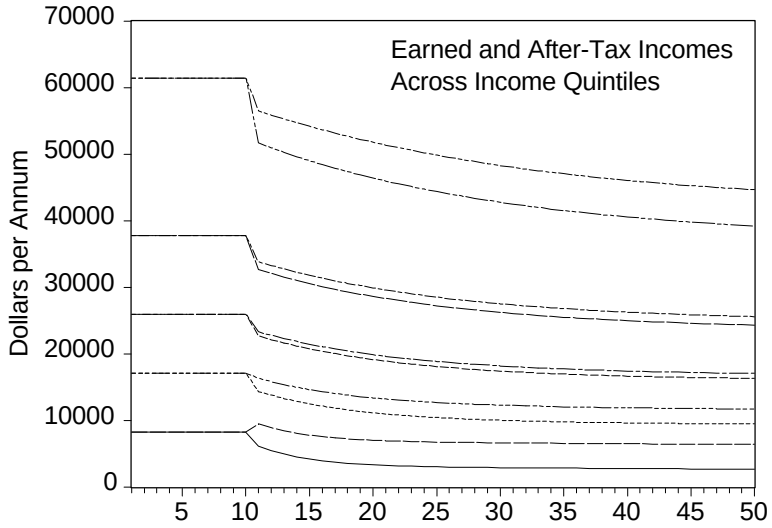

1400
1300
1200
1100
1000
900
800
700
Hours per Annum
12000
10000
8000
6000
4000
2000
Dollars per Annum
5
10
15
20
25
30
Years
Labour Supply
After-Tax Income
Earned Income
Consumption

FIGURE 3
Transition Dynamics Following
Implementation of the Welfare State



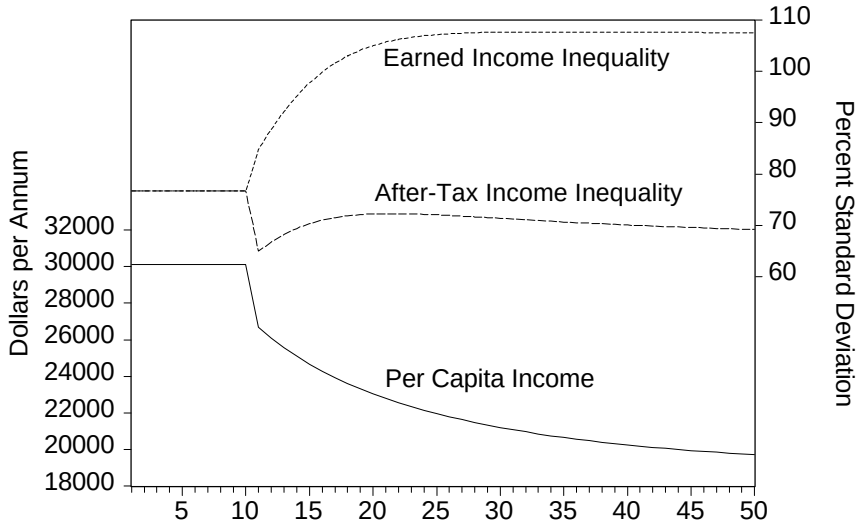
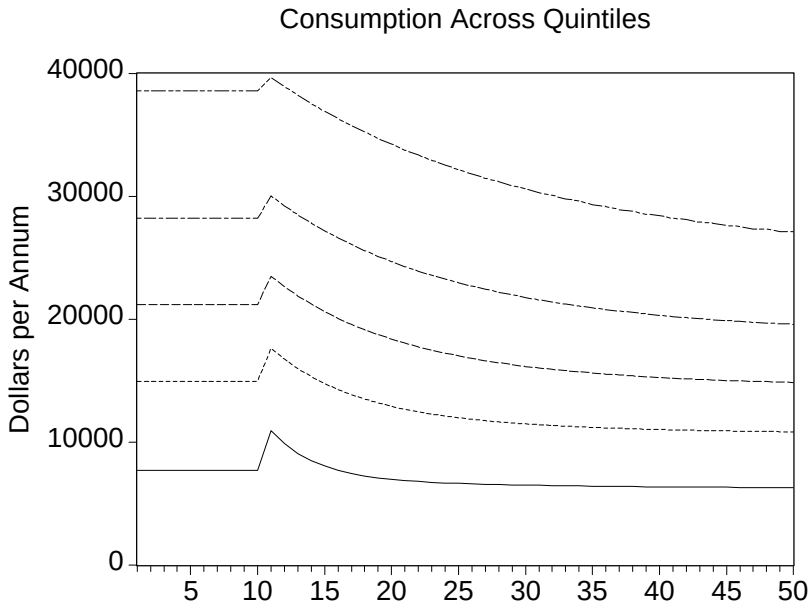


FIGURE 4
Transition Dynamics Following
Implementation of the Welfare State



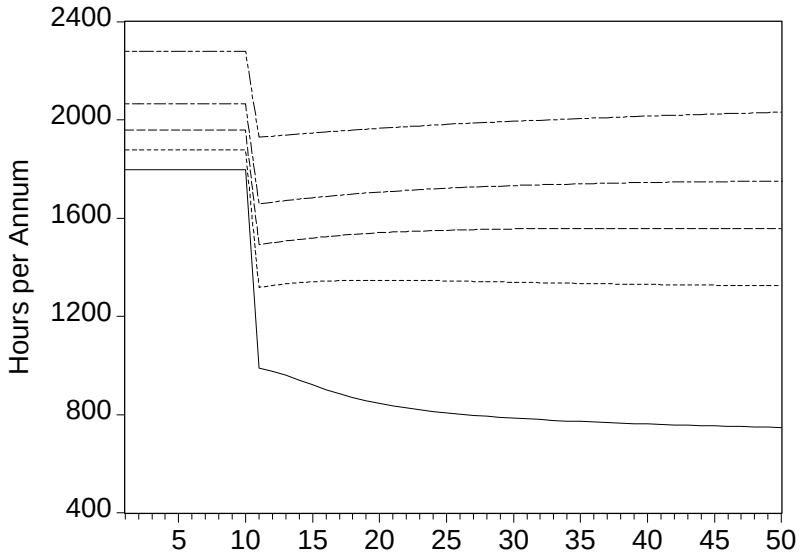


FIGURE 5
Income-Tax Rate Following Implementation
of the Welfare State

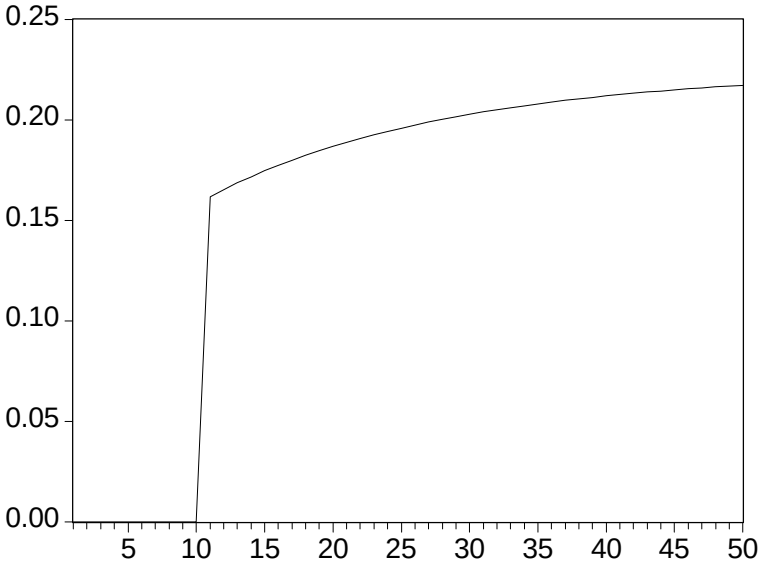
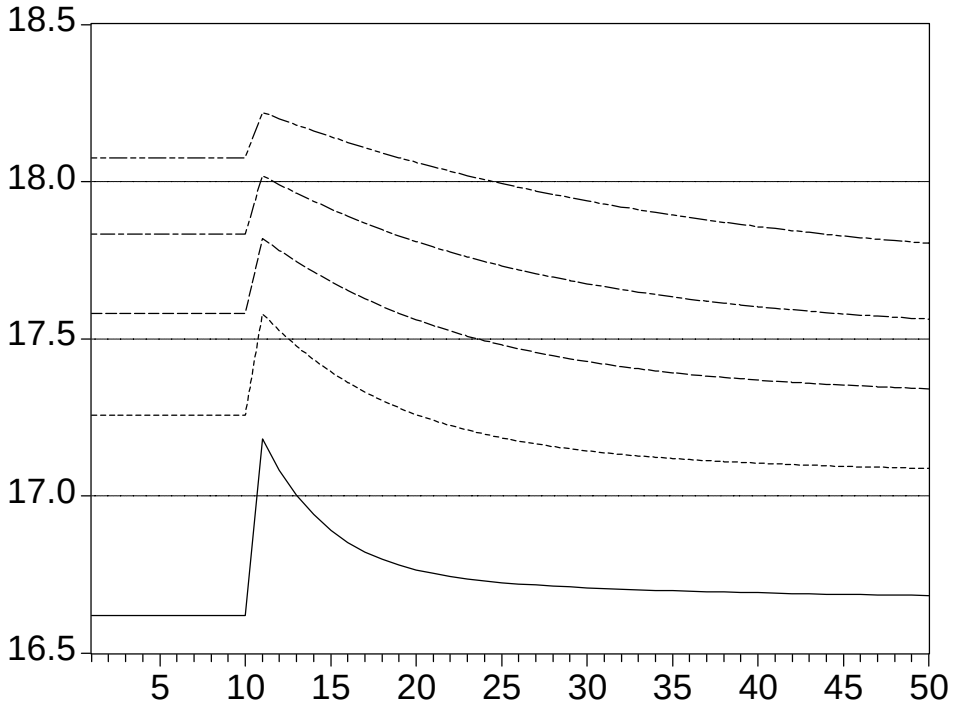


FIGURE 6
Momentary Utility Following Implementation
of the Welfare State



9 References

1. Andolfatto, David and Paul Gomme (1996). "Unemployment Insurance and Labor-Market Activity in Canada," *Carnegie-Rochester Conference Series on Public Policy*, 44: 47–82.

2. Andolfatto, David and James Redekop (1998). "Heterogeneous Time-Preference and the Distribution of Wealth," Manuscript: University of Waterloo.

3. Becker, Gary S. and Casey B. Mulligan (1997). "The Endogenous Determination of Time Preference," *Quarterly Journal of Economics*, CXII(3): 729–758.

4. Burbidge, J.B., Magee, L. and A.L. Robb (1996). "Canadian Wage Inequality over the Last Two Decades," Working Paper 96–01: McMaster University, Canada.

5. Cooley, Thomas F. and Jorge Soares (1998). "A Positive Theory of Social Security Based on Reputation," Working Paper: University of Rochester.

6. Fisher, Irving (1907). *The Rate of Interest*, Macmillan.

7. Freud, Sigmund (1911). "Formulations on Two Principles of Mental Functioning," in *The Complete Psychological Works of Sigmund Freud*, XIII, Hogarth Press, London.

8. Jianakopolos, Nancy and Paul Menchik (1997). "Wealth Mobility," *The Review of Economics and Statistics*," LXXIX(1): 18–31.

9. Jovanovic (1997). "Vintage Capital and Inequality," forthcoming in the *Review of Economic Dynamics*.

10. Juster, F. Thomas and Frank P. Stafford (1991). "The Allocation of Time: Empirical Findings, Behavioral Models, and Problems of Measurement," *Journal of Economic Literature*, XXIX(2): 471–522.

11. Krussel, Per, Rios-Rull, Victor-José and Anthony A. Smith (1997). "Politico-Economic Equilibrium and Economic Growth," *Journal of Economic Dynamics and Control*, 21: 243–272.

12. Krussel, Per and Anthony Smith (1997). "Income and Wealth Heterogeneity in the Macroeconomy," forthcoming in the *Journal of Political Economy.*

13. Lawrance, Emily C. (1987). "Transfers to the Poor and Long Run Savings," *Economic Enquiry*, 25: 459–478.

14. Lawrance, Emily C. (1991). "Poverty and the Rate of Time Preference: Evidence from Panel Data," *Journal of Political Economy*, 99(1): 54–77.

15. Little, Bruce (1995). "The Gap that Wants to be a Chasm," *The Globe and Mail*, Monday, July 10.

16. Levy, Frank and Richard J. Murnane (1992). "U.S. Earnings Levels and Earnings Inequality: A Review of Recent Trends and Proposed Explanations," *Journal of Economic Literature,* XXX(3): 1333–1381.

17. Maital, Shlomo and Sharona Maital (1977). "Time Preference, Delay Gratification and the Intergenerational Transmission of Economic Inequality: A Behavioral Theory of Income Distribution," in *Essays in Labor Market Analysis in Memory of Yochanan Peter Comay*, Edited by Orley C. Ashenfelter and Wallace E. Oates, John Wiley & Sons.

18. Moffitt, Robert A. (1990). "The Distribution of Earnings and the Welfare State," in *A Future of Lousy Jobs*? Edited by Gary Burtless, The Brookings Institution, Washington, D.C.

19. Murray, Charles A. (1984). *Losing Ground: American Social Policy, 1950–1980*, Basic Books.

20. Ogaki, Masao and Andrew Atkeson (1997). "Rate of Time Preference, Intertemporal Elasticity of Substitution and Level of Wealth," *The Review of Economics and Statistics*, LXXIX(4): 564–572.

21. Olson, Macur and Martin J. Bailey (1981). "Positive Time Preference," *Journal of Political Economy*, 89(1): 1–25

22. Rae, John (1834). *Statement of Some New Principles on the Subject of Political Economy*, Boston: Hilliard, Gray, and Co., Reprinted by Augustus M. Kelley, Bookseller, New York (1964).

23. Ramsey, Frank P. (1928). "A Mathematical Theory of Savings," *Economic Journal*, 38: 543–559.

24. Schiller, Bradley (1977). "Relative Earnings Mobility in the United States," *American Economic Review*, 67: 926–941.

25. Statistics Canada (1996). "Income After Tax, Distributions by Size in Canada 1994," Catalogue No. 13–210–XPB, Ottawa.

26. Stokey, Nancy L. and Robert E. Lucas, Jr. (1984). "Optimal Growth with Many Consumers," *Journal of Economic Theory*, 32: 139–171.